

RD-1C Assembly Instructions Updated: 10/03/07

******PLEASE READ INSTRUCTIONS COMPLETELY BEFORE STARTING ASSSEMBLY******

Note! **Check all packing material for small parts before discarding.**

1. Your engine should already be equipped with an automatic transmission counter-weight of the appropriate year to match the engine. The eccentric shaft nut should be installed with Loctite (Blue, Medium strength) and torqued to 350 foot-pounds. Your engine must also be equipped with a 1986 – 91 RX-7 automatic transmission flywheel to be compatible with the RD-1A/B/C. Note that the RD-1A/B/C drive is designed to work with a 1988 non-turbo RX-7 manual transmission starter. In case you happen to have a starter from a different year RX-7, the model years 1987 – 1991 are all the same as far as we have been able to determine but it must be a non turbo, manual transmission model.

2. Mount the automatic transmission flywheel to the counterweight. I suggest using the stock Mazda flywheel bolts which are of very high quality and have integral washer shoulders. If you have the stock Mazda washer plate for the flywheel, install it as well. Note that the washer plate goes on top of the flywheel, not between the counter-weight and the flywheel. The flywheel bolts should be installed with medium strength Loctite. Clean the threaded holes of the counter-weight and the bolts with acetone before applying Loctite.

Note! If your engine is an RX-8 Renesis engine, the RX-8 flexplate spacer (steel object just behind the RX-8 flexplate) is not to be used with the RX-7 flexplate. Remove it prior to installing the RX-7 flexplate. You also have to either shorten the RX-8 bolts or replace them with RX-7 flexplate bolts to compensate for the depth of the RX-8 spacer.

3. Before mounting the damper, make certain that there is no pilot needle bearing in the end of the crankshaft. Engines that were equipped with manual transmissions may have this bearing and it must be removed before the input shaft pilot will fit into the crankshaft. These can sometimes be difficult to remove. I have had to resort to carefully grinding through the outer race with a small stone in a Dremel tool in order to remove some of the more stubborn ones. Clean the crankshaft pilot hole and liberally apply a good quality wheel bearing grease. Before mounting the damper, make sure that the pilot on the input shaft/sun gear assembly will slide into the crankshaft pilot hole without binding. Refer to the drawing on Damper / Flywheel assembly details during the following instructions. First install four 7/16" damper bolts with medium size diameter washers (marked 7/16 – USA) from the back-side (engine side) of the flywheel. Install a large AN7 washer on the front side on each bolt. Position them so that the side with the rounded edges goes against the rubber damper. Now mount the damper assembly to the flywheel by sliding it onto the four bolts until it is seated against the flywheel. Install another large AN7 washer over each damper block (rounded edges against the damper) followed by a small AN7 washer and an elastic stop nut. Tighten these nuts until they start to tighten on the damper drive bushings, then back off one full turn. These bolts will be tightened later.

4. **Refer to the attached photos during procedures 4 – 6.** Install the 12 long quarter inch bolts with one washer through the 12-quarter inch holes in the adapter plate. The drive is shipped with two of these bolts in the main gear housing to hold it and the planet carrier housing to the shipping skid. Install these bolts from the backside of the plate (side facing engine). The backside can be identified by the input shaft seal that is installed in a counter-bore in the backside of the plate. Note: You may polish or paint the spacers for esthetics if you wish but *do not alter or paint the mating surfaces of the spacers.*

5. Facing the adapter plate from the front with the starter mounting hole at the six o-clock position, install four 10 mm bolts and washers in the two holes at the upper right and lower left of the plate. The lowest bolt in the lower left pair should be a short (110 mm) bolt. The other three bolts should be 120 mm long.

6. Slide the long curved spacer onto the two bolts at the lower left. Slide the short spacer with two holes onto the bolts at the upper right. Orient the spacers so that their counter bored holes match up with the locating dowels on the engine.

7. Now mate the adapter plate and the two spacers up to the engine with the starter mounting hole at the six o'clock position. Thread these four bolts into the engine and make sure that none of them bottom out in the holes before tightening on the adapter plate. The depth of these holes seems to vary on different year engines. If the hole is too shallow, it will be necessary to either add a washer or to or cut a small bit of the threaded end of the bolt off. After verifying that the bolts will properly tighten, back them off about one turn. Make sure the counter-bores in the spacers slide onto the locating dowels during this procedure. Note: The dowels should be clean and free of burrs before doing this step. Also, note that one of the bolt pattern holes in the engine is not threaded. Install this bolt with a 10mm nut.

8. Slide the short rectangular spacer between the upper left adapter plate hole and the engine. Install a 10 mm bolt (with washer) through the plate and spacer and thread it loosely into the engine. Slide the short trapezoidal shaped spacer between the lower right hole and the engine. Orient it as shown in the attached photo. Slide a short (110 mm) bolt with washer through the plate and spacer and loosely thread it into the engine making sure that it does not bottom out prematurely as explained in the previous step.

9. While supporting the weight of the adapter plate, tighten the six 10 mm bolts in small steps until they are snug (about 10 foot pounds). These bolts will later be torqued to their final value. I have not found any tendency for these bolts to loosen but you may Loctite them if you wish. The adapter weight should be supported to ensure that the plate accurately self-centers on the hole pattern. Make sure the single bolt spacers are rotated to their proper positions before tightening the bolts. A few builders have reported that one or more of the blind threaded holes in the engine block were not deep enough to allow the bolts to tighten before bottoming in the block. If this should occur on your engine, cut enough off the threaded end to allow proper tightening or add an additional washer to the bolt before inserting through the plate and spacer.

10. I would recommend that you do a trial assembly of the gear drive **without sealant** to insure that all the parts are properly aligned and that you are familiar with how all the parts fit together. Clean the sun gear assembly and its thrust bearings. The –C model of the reduction is designed for higher maximum engine RPM so it uses a stack of two needle bearings instead of the single roller bearing used on the A and B models. Be sure to assemble this bearing stack properly. Note that the thick bearing race with the larger I.D. must go on the shaft first and that the flat face of the race is toward the needle bearing. This is followed by one needle bearing followed by a thin 1mm bearing race, one more needle bearing and then the thick smaller ID bearing race. The nylon snubber spacer is packed with the input shaft, so put it aside until it is needed later.

11. Prior to assembling the drive on the adapter plate might be a good point at which to familiarize yourself with checking the input shaft endplay. This will also get you familiar with how the parts of the drive go together. First, place the main housing on your workbench with the prop hub facing down. Assuming you have not removed them, the planet carrier assembly, it's thrust bearing and the ring gear will already be in place. If not, install them now. Do not install the O-Ring that sits behind the ring gear for this test as it will prevent the spacer housing from seating against the main gear housing. Next, install the nylon snubber over the prop shaft so that it rests against the planet carrier bulkhead. One side of the snubber I.D. may be beveled and if so, the beveled side goes down. If both sides are beveled, place the most deeply beveled side down. Now place the rear spacer ring over the main housing with the flat side up. Lightly tap the spacer around its circumference with a nylon head hammer (or similar blunt instrument soft enough to avoid denting the aluminum spacer ring) to insure that it is seated into the recess on the bottom side. Now oil the input shaft pilot bearing and slide the sun gear into the planet assembly, turning it as necessary to align it with the planet gears. Push it all the way down until it seats against the snubber. Install all the parts of the input shaft thrust bearing assembly on the back of the sun gear. See the drawings for the proper order of assembly. Turn the input shaft and verify that the main housing rotates freely without binding at any point in its rotation. Now check the end play of the whole assembly by placing a ruler edge-wise across the spacer so that it overlaps the rear race of the input shaft thrust bearing. There should be

between .001 and .030" clearance between the lower edge of the ruler and the thrust bearing. If it appears that there is no clearance, push down on the input shaft. If you can measure any clearance when the shaft is pushed down, the clearance is acceptable as long as it is less than .031". This check should be done at any time that the gear drive is assembled and after inspection or maintenance.

12. When you are ready for a trial or final assembly, apply a liberal coating of wheel bearing grease to the input shaft pilot. When properly assembled, hold the thrust bearing assembly in place and slide the input shaft through the oil seal in the adapter plate and into the damper spline. The thrust bearing should seat against the adapter plate when fully inserted. The input shaft pilot and spline is a close tolerance fit and may require a few light taps with a rubber mallet to seat the sun gear and bearing against the adapter plate.

13. Apply some wheel bearing grease to the nylon snubber spacer to hold it in place and slide it over the aft end of the propeller shaft against the planet bulkhead in the main gear housing. See the exploded drawing for details on how the gears are assembled in the housing. Note that the nylon spacer ID is chamfered on one side. This side must go against the planet gear assembly bulkhead. The nylon snubber looks small and unimportant but it is vital to the proper operation of the drive. DO NOT leave it out.

14. Now line up the punch marks on the gear housing spacer and adapter plate and slide it onto the twelve bolts in the adapter plate until it is flush against the adapter plate. If this were the finally assembly, you would now put the ring gear retainer O-ring in place with some wheel bearing grease behind the ring gear on the main housing. It can be left out for now since this is only a trial assembly.
15. After the gear housing spacer is in place, slide the main gear housing onto the twelve bolts, also lining up its punch mark with the planet carrier and adapter plate mark. Push the main gear housing so that it fits into the recess in the gear housing spacer. You may have to joggle the prop hub around to get the gear teeth to properly mate during this step. . Always follow the cardinal rule when assembling mechanical devices: **"Don't force it! if it doesn't fit, find out why!"** Using a long screwdriver or similar tool, slide the twelve ¼" bolts forward so that the threaded ends are protruding through the main gear housing. To ensure that the drive is correctly oriented, check to see that the oil return port near the rear of the gear housing is in the 6 O-clock position. The 1/8" NPT threaded hole for the oil supply line (top) should be at the 11:30 position.

16. Install four-quarter inch nuts and washers at the 12, 3, 6 and 9 o-clock positions on the main gear housing and tighten them until they are just snug. There should be no more that 4 threads on the bolts showing past the end of the nuts. If there are more than 4 threads showing, an additional washer should be used under the nut to insure that the threads of the nut do not cut into the shank of the bolt.

17. To aid in centering the damper assembly on the input shaft spline, grab the flywheel and pull the engine through at least one full revolution. Now snug up the four damper bolts and torque them to 40 foot pounds in small steps.

18. This step is intended to verify that everything is assembled and aligned properly. With your hands, rotate the prop hub back and forth through the system lash travel (this is only a half degree or so) and note the amount of force needed to do this. This should be a relatively low force requiring only one hand. Note the position of the flywheel and rotate the engine crankshaft ¼ turn. The engine should be free enough to do this by pulling on the starter ring gear. Again check the force needed to turn the prop hub through the system lash. Repeat this procedure through one complete revolution of the engine. The force needed to rotate the hub should be approximately the same in all four positions. If the system seems to be binding in any of the four positions, try loosening the 4 damper bolts about 1 ½ turns and repeat this step. If the results are now good it may indicate that the damper was not properly aligned before tightening the bolts. Tighten them again and repeat the test. If you are unable to get good results after several attempts, try the following step.
19. The above procedure has succeeded in getting good alignment on all drives built to date, but if this fails, the adapter plate may be miss-aligned. If this is the case, loosen the six bolts in the adapter plate until they are barely snug. Using a rubber mallet or similar tool, tap the edge of the plate from one side and re-sung the bolts to about 10 foot pounds then recheck the prop hub force as in the previous step. Try this step tapping on all four sides of the adapter plate (one at a time) if necessary. If you are unable to get good results after trying this, call for further instructions.

20. Once you have gotten good alignment, torque the 10mm adapter plate bolts to 25 – 30 foot-pounds. These bolts may now be Loctited if you wish. Note! Remove only 1 bolt at a time when doing this in order to keep everything in alignment. When tightening the 6 adapter plate bolts, make sure the two spacers with single bolt holes are oriented correctly and that the bolts are properly torqued before any attempt is made to start the engine. If these spacers are allowed to turn and contact the flywheel, total destruction of the drive could result.

21. Remove the gear drive from the adapter plate. Clean all the mating surfaces of the gear drive and insure that all internal parts are clean. The gear drive requires the same level of cleanliness that an engine does due to the close tolerance bearings and small oil passages. You may leave the sun gear and thrust bearing in place if you intend to do the final assembly soon.

FINAL ASSEMBLY

Make sure the main gear housing, ring gear Planet thrust bearing, planet gear assembly and nylon snubber/spacer are all properly assembled and the input shaft and bearing is in place before proceeding.

22. *Don't rush, but expedite the following steps so that the gasket maker does not start to dry before completing this procedure:*

- ✓ Apply RTV silicone gasket maker (I recommend Permatex Ultra Grey) to the back surface of the gearhousing spacer. Be sure to surround the ¼ inch bolt holes on all sides with the silicone sealant to prevent oil seepage down the bolt holes but don't over do it. You don't want a large amount of sealant to squeeze out inside the drive.
- ✓ Slide the spacer onto the twelve bolts (remember to match up the punch marks on the planet housing and the adapter plate) until it contacts the adapter plate.
- ✓ Use some wheel bearing grease to hold the ring gear retainer O-ring in place behind the ring gear. Apply sealant to the mating surface of the main gear housing (same as on the gear housing spacer) and slide it onto the bolts, again matching up the punch marks. Push the gear housing onto the spacer. Now slide the ¼" bolts forward until they protrude through the main gear housing.
- ✓ Install nuts and washers on all 12 bolts and torque them all evenly in small steps. Use a cross pattern to tighten the nuts, i.e., 12 o-clock, 6 o-clock, 9 o-clock, 3 o-clock etc. On this initial tightening, you should not tighten them to their final spec of 50 inch pounds but just snug them up using a screwdriver grip nut driver and firm wrist pressure. Allow the sealant to set overnight then use a cross pattern and torque them to 50 inch pounds.
- ✓ Note that this is **INCH POUNDS**, **not** foot pounds. (Yes, some builders have made this mistake). **Resist the urge to over-tighten these nuts.**
- ✓ Verify that the system lash play is still free in several crankshaft positions.

23. You are now ready to plumb the oil feed and return lines. The oil feed hole on top of the drive is taped for a 1/8" NPT fitting and we suggest using ¼" ID hose or tubing (AN4 size) rated for 200 PSI or more for the feed line.. **IMPORTANT: Unlike the Ross and some other gear drives, no restrictor is to be used in the oil feed line! .** The RD-1A/B/C drive is not 'drip lubricated' and does require pressurized oil to properly lubricate and cool the internal components.

24. The two return holes are taped for ¼" NPT fittings The two return lines may be "T'd" together and routed to the engine crankcase with a single line. Use 3/8" ID tubing (AN-6 is OK) or hose for this connection. The return point should be as low as possible on the engine but still above the full oil line in the engine. If you removed the oil injection pump drive shaft in the engine, that makes an adequate return point. If your engine is a turbo model, the turbo oil return port is a good location. These are both located on the aluminum front cover of the engine. See the photo of the engine on page 7 for another suggested oil return point. Remember that the starter mounts below the gear housing and plan your oil return lines so as not to interfere with mounting the starter.

25. Now install the starter (1988 non-turbo RX7 manual transmission model should be used) in the starter hole. *Note: The prop hub should be protected from rust by spraying it with a corrosion inhibiter like Corrosion X or by painting it. Do not paint the drive lugs as they are a close tolerance fit into the counter bores in the prop.*

26. When installing any new power plant on an aircraft, you should complete a thorough ground test before attempting flight. I would suggest at least 5 hours of engine run time with a minimum of 1 hour being at full throttle.

27. These instructions cover all the basic steps involved with installation but you may encounter other questions during the process. Please call if you have any questions or problems during the installation of your drive and thanks again for choosing Real World Solutions.

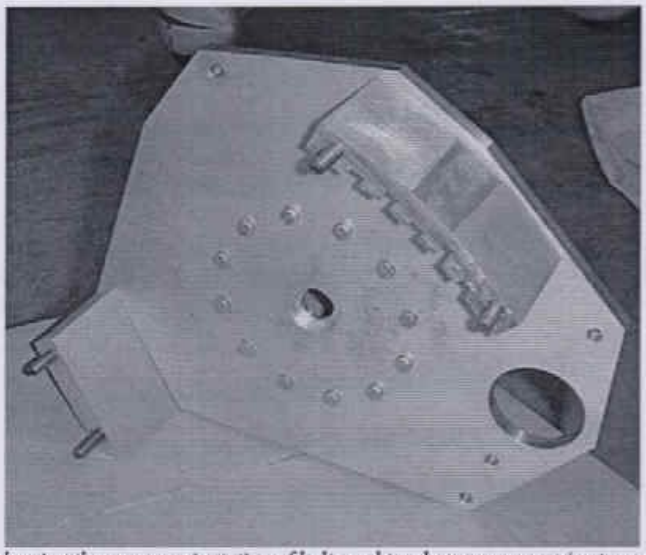
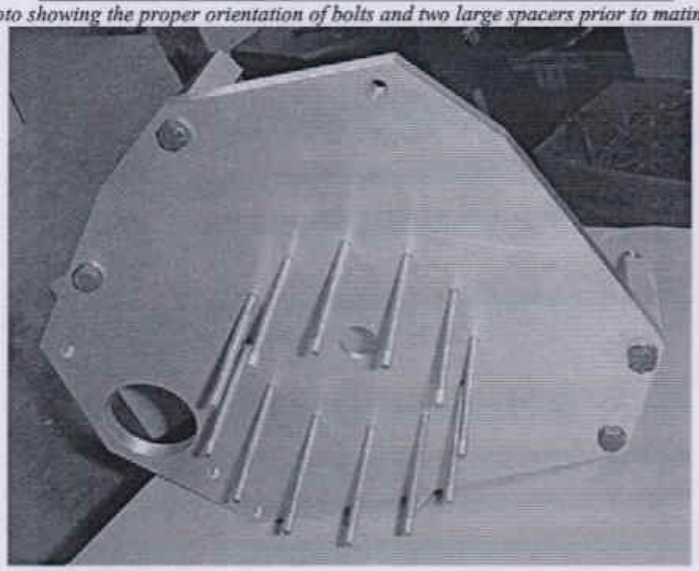
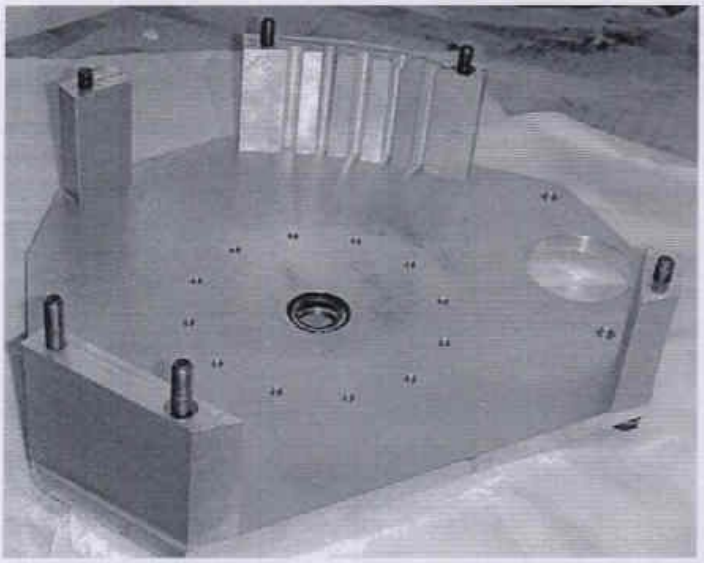


Photo showing the proper orientation of bolts and two large spacers prior to mating the adapter plate to the engine.



These two photos show the adapter plate after inserting the bolts and spacers in steps 4 – 6. Your plate will have the input shaft oil seal installed. The seal was not installed when these photos were taken.



This photo shows the proper orientation of the small spacers with one bolthole. Oil seal is installed in this shot.

I would suggest that you temporarily install the RD-1 without the sealant while you work out your engine mount, cooling systems, cowl, and other innumerable details encountered during the construction of the aircraft.

Removing the drive after installation.

When removing the drive for inspection or maintenance, the following tips may be helpful. The silicone sealant used between the drive and adapter plate can be amazingly difficult to break loose. Resist the urge to pound on the gear housing to do this. I would suggest drilling a quarter inch hole into the planet carrier housing (between two of the bolt hole positions) about 1/2" away from the adapter plate.

Make this hole ½ inch deep. DO NOT DRILL ALL THE WAY THROUGH THE HOUSING! Insert a short ¼" bolt or clevis pin into the hole and use a pry bar between the plate (protect the plate with duct tape, piece of plywood, etc.) and the pin to break the housing free of the plate. While doing this, leave at least a couple of the long ¼" bolts with nuts loosely on them through the gear housing and plate so that the housing does not fall off and no side loads are put on the bearings & shafts in the drive when the housing breaks free of the adapter plate.

Inspection Intervals

The main drive housing should be removed from the adapter plate after the first 25 hours of flight to inspect the input shaft thrust bearing, sun gear, planet gears and the ring gear. If this inspection is satisfactory, the next inspection interval can be increased to 500 hours or at the following annual aircraft inspection, which ever comes first. If this inspection is satisfactory, inspection intervals can be increased to 250 hours. . A chip detector is now in development stages which will be retrofitable to all RD-1 gear drives. The use of this detector will eliminate the 25 and 100 hour inspection requirement. An alternative to the chip detector is the use of a magnetic oil drain plug. If no metal chips are found on the plug, the 25 and 100 hour inspections can be skipped if no other adverse signs are noted.

Modifications

Please resist the urge to modify the design and construction of the RD-1. The design has evolved over several years and hundreds of hours of testing.

If you want to make any changes to the drive, please call and discuss it with us to ensure that the proposed changes do not compromise any critical parameters of the drive.

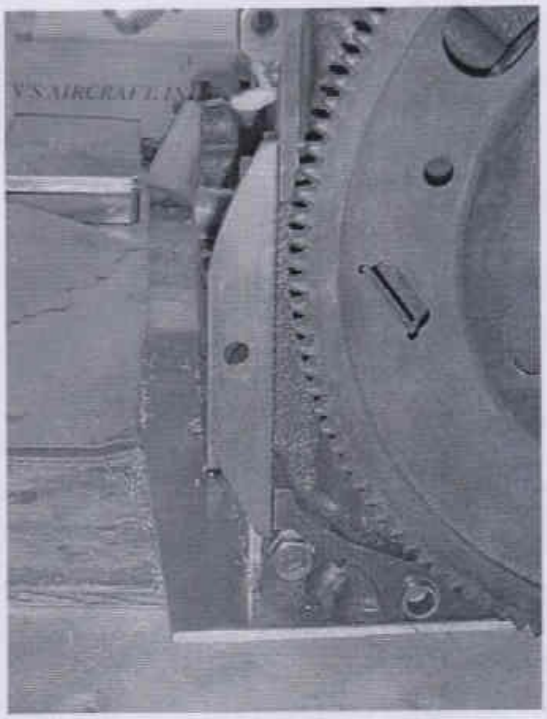
I have 2nd Gen

Notes to 3rd Gen 13B, Renesis and 20B users.

The RD-1A/B/C was developed and tested on 2nd Generation (1986 – 1991) 13B engines. These engines all had a common bellhousing bolt pattern regardless of transmission used. Later engines have basically the same bolt pattern but on 3rd Gen automatic transmission equipped engines, Renesis (RX-8) and 20B engines, one of the bolt holes is missing where the side mounted starter was installed. This is easily remedied by fabricating a bracket to get back the missing hole.

As shown in the photos below, a piece of ¼" angle iron is used to make the bracket for the Renesis and other engines with the "missing hole". The bolt holes on the side of the engine vary in size and spacing on the various engines. In the case of the Renesis engine, only the top hole was present. You can see that the bottom hole has only been drilled with a small pilot hole in the first photo. The hole in the engine housing was later drilled and tapped for an 8mm bolt (same size as top).





The front face of the bracket must be flush with the face of the engine. Once you have the bracket properly located and bolted in place, temporarily mount the adapter plate and all spacers and lightly tighten the bolts. Use a 10mm transfer punch through the adapter plate and spacer to mark the bracket. Now remove the angle bracket and drill the marked spot with a small pilot hole then enlarge it to 10mm with a 10mm drill bit. Clean & paint bracket to taste.

Note: The threaded hole in the foot of the rotor housing (photo on left) was used as an oil return point for the gear drive.

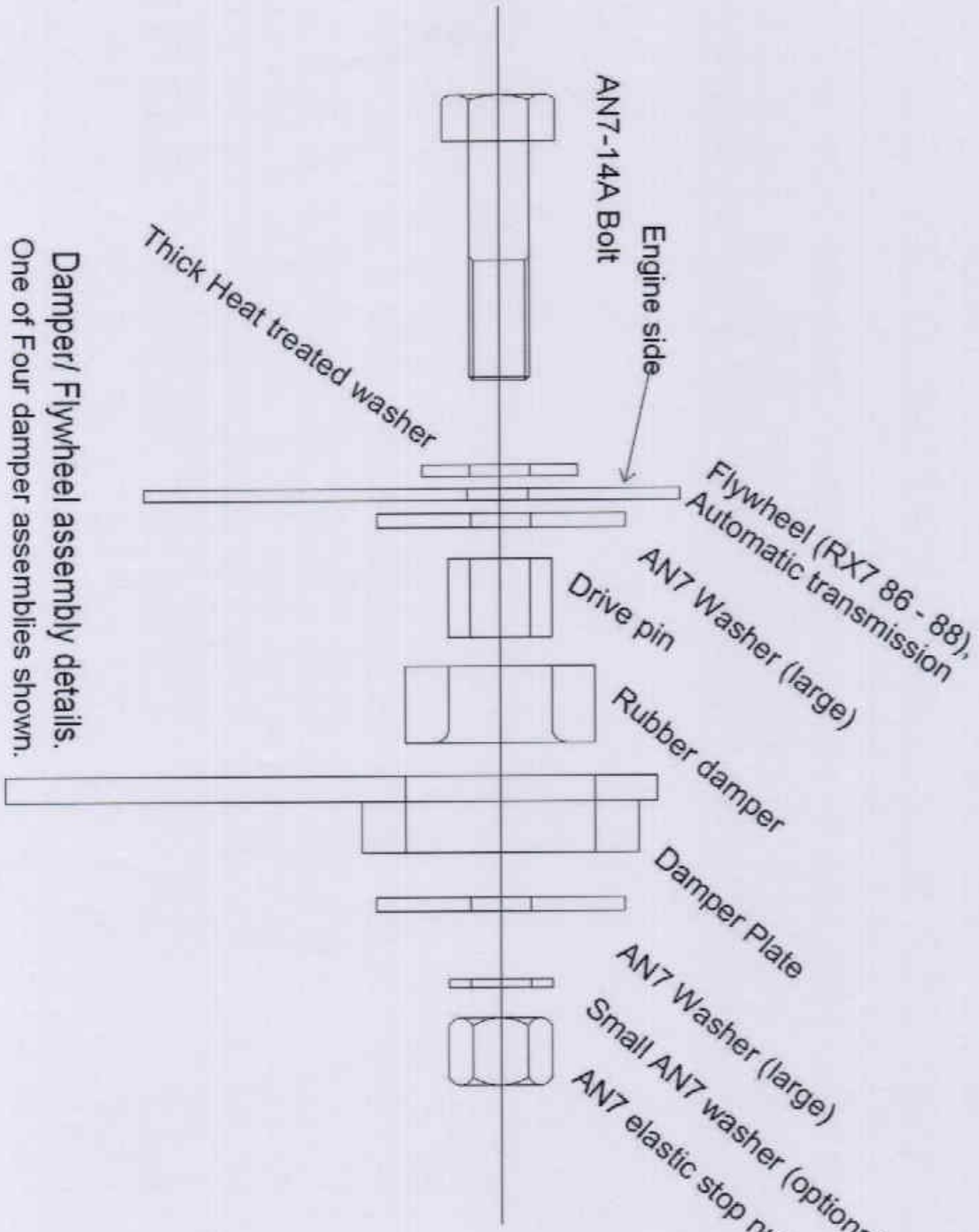
Warranty

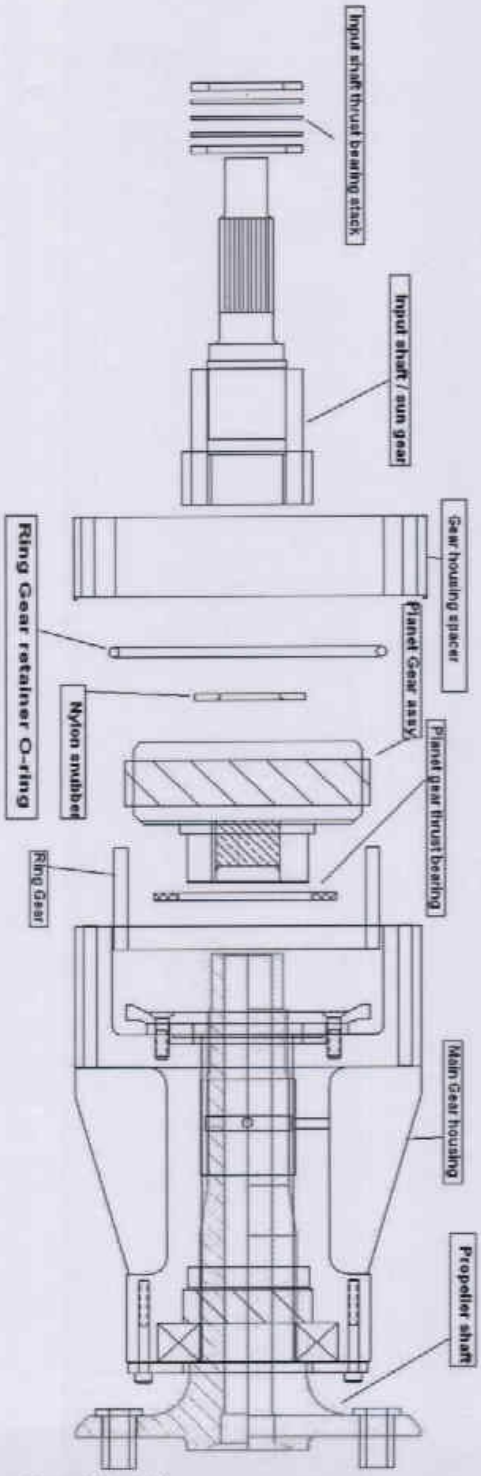
The RWS RD-1A/B/C gear drive comes with a 1 year warranty from the time you start *flying the unit*. We will repair, free of charge (except for shipping costs), any defect in material or manufacture. Owner will be responsible for returning the unit to us, packed in a manner that prevents further damage. Please ship via an insured method – we cannot be liable for units lost in shipping. To activate your warranty PLEASE NOTIFY US OF THE DATE OF YOUR FIRST FLIGHT.

Product Support

If you have installation or operational questions, please email us at tcrook@rotaryaviation.com
Repair service is available by sending the unit back to RWS. Repair during the warranty period will be at no charge other than return shipping costs.
Happy flying from all (three) of us here at Real World Solutions.

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Damper/ Flywheel assembly details.
One of Four damper assemblies shown.
Thick Heat treated washer
AN7-14A Bolt
Engine side
Flywheel (RX7 86 - 88),
Automatic transmission
AN7 Washer (large)
Drive pin
Rubber damper
Damper Plate
AN7 Washer (large)
Small AN7 washer (optional)
AN7 elastic stop nut



RD-1C Exploded View

PARTS LIST - RD-1C

You should find the following parts in the shipping container of the RD-1C

1. Main Gear housing with propeller shaft installed. (First 5 items will be bolted together on the shipping skid with two bolts, washers & nuts)
2. Gear housing spacer
3. Ring Gear
4. Planet Gear assembly with thrust bearing
5. Ring gear retainer O-ring, 5.125" OD, x .190" thick
6. Nylon snubber/spacer (To be Installed on propeller shaft between sun gear and planet gear assembly)
7. Input shaft and sun gear with thrust bearing (packed along with nylon snubber/spacer above)
8. Adapter plate with oil seal installed. (unless ordered without adapter plate)
9. 4 Adapter plate spacers "
10. 12 AN4 -47A bolts (including two used to bolt gear housing to shipping skid)
11. 12 AN4 -365 elastic stop nuts
12. Damper plate (aluminum) with input shaft spline drive.
13. 4 Damper drive lugs (steel)
14. 4 Rubber dampers (1.375" OD x .75" ID) (items 12,13 & 14 are furnished pre-assembled)
15. 4 AN7-14A damper bolts
16. 8 AN7 washers (large)
17. 4 AN7 washers (small)
18. 4 7/16" ID thick washers
19. 24 ¼" washers
20. 4 120mm long 10mm dia. Bolts (Unless ordered without)
21. 2 110mm long 10mm dia bolts "
22. 8 10mm washers "
23. 4 10mm nuts "
24. Instructions (this document)

Important Letter to Real World Solution's Redrive Customers
RE: "Universal Motor Mount Plate" and other changes.

A number of builders have expressed an interest in using the Real World Solutions gear reduction drive with an alternative "universal motor mount plate" as discussed on some of the on-line rotary discussion groups. Since some builders are deciding to go this route, I need to get something on record about it.

This plate may work out just fine for some applications and I think that there is probably no danger of the thing breaking due to the loads imposed by mounting the engine this way. ***I do have some reservations however.***

1. The success of the drive is ***very dependant*** on the precision of this plate (and the spacers) to keep all the moving parts concentric and straight in-line. You must take responsibility for maintaining this precision if the standard adapter plate is not used or is modified.

2. I don't have a problem with moving the starter location but using the adapter plate for the engine mount is another matter. The loads on the plate and spacers when using it for an engine mount probably will not break anything but I do not know if it will it cause enough deflection to upset alignment or concentricity. This is especially true since if using different spacers.

3. Since I am not involved, there is no coordination with ongoing design changes being made to the drive. I simply do not have the time to coordinate this kind of thing and would not want to assume the liability for something that I have no control over even if I did. For this reason, I can not provide a warranty on any drive used with anything other than the adapter plate that I furnish.

It goes without saying that none of this is meant to discourage innovation or experimentation. It is just a good idea to understand all the ramifications before setting off on a new course.

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January 4, 2001